ASC Dawn

Supercomputing to Advance National Security and Science

A new-generation National Nuclear Security Administration (NNSA) supercomputer for the Advanced Simulation and Computing (ASC) Program—Sequoia—will deliver the required petascale capabilities necessary to ensure the continued safety and reliability of the nation's aging nuclear deterrent. As the latest system from the long-term partnership between Lawrence Livermore National Laboratory (LLNL) and IBM, Sequoia is a national asset and multi-national-laboratory resource that will create an advanced simulation environment approximately 10 times more powerful than today's most capable supercomputing system.

ASC Dawn—the initial delivery system for Sequoia—installed at Lawrence Livermore National Laboratory.

The Sequoia procurement consists of two computing systems. Dawn—the IBM Blue Gene/P system that was recently installed and is being dedicated at LLNL on May 27, 2009—is the smaller of the two at 0.5 petaFLOPS (quadrillion floating operations per second). Dawn will lay the applications foundation for multi-petaFLOPS computing on Sequoia.

Sequoia, the 20-petaFLOPS final system scheduled for delivery in late 2011, has two main NNSA missions, both of which require "predictive simulation" of complex systems. Predictive simulation is not just computing the behavior of a complex system (the results), but also generating a precise quantification of the uncertainty associated with the results. This is analogous to the "margin of error" cited in scientific and technical papers or commonly used to qualify poll or survey results. Achieving predictive simulation is critical to resolving scientific problems when validation by physical experiment (for example, underground nuclear testing) is impossible, impractical, or prohibited by law or treaty. Predictive simulation is necessary to sustain the

LLNL-MI-412827

nation's shrinking nuclear deterrent into the future as the deterrent continues to age. Sequoia's two missions are:

- To quantify the uncertainties in numerical simulations of nuclear weapons performance. This will require the execution of vast suites of simulations not possible on current systems.

- To perform the advanced weapons science calculations needed to develop the accurate physics-based models for weapons codes.

Lawrence Livermore computer scientists inspect a newly installed rack for Dawn, a 500 teraFLOPS (trillion floating operations per second) IBM BlueGene/P system. Dawn will help lay the foundation for the 20 petaFLOPS (quadrillion floating operations per second) Sequoia system.

Dawn and Sequoia were selected, in part, because of their tremendous energy efficiency. These systems are two to three times more energy efficient in terms of computing delivered per watt used compared to supercomputers of similar capability. For systems of this scale, energy efficiency is of central importance and absolutely essential to drive down operating costs.

The technical capabilities and scientific applications developed on Dawn have implications that go far beyond stewardship of the nation's nuclear deterrent to other computationally intensive national security challenges, such as counterterrorism, non-proliferation, and arms control. Research in energy, climate change, biomedicine, natural resource management, and data mining will also benefit greatly with advanced computational abilities. Advancing state-of-the-art supercomputing is also vital to maintaining the nation's economic competitiveness as well as its scientific and technological preeminence.

For more information about ASC Dawn and Sequoia, see the ASC at Lawrence Livermore Web site: https://asc.llnl.gov/.